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INDIVIDUAL TREE DIFFERENCES CONFOUND EFFECTS OF GROWTH REGULATORS IN ROOTING SUGAR MAPLE SOFTWOOD CUTTINGS

Abstract.—Softwood stem cuttings from three mature sugar maple trees were treated with several types and concentrations of growth regulators. Lack of statistical significance was due to extreme variability in tree response: low levels of auxin stimulated rooting in two study trees, while auxins inhibited rooting in the other tree. It is postulated that variations in rooting response may have been caused by corresponding differences in endogenous levels of naturally-occurring auxins.

In vegetative propagation by stem cuttings, it is generally recommended that the basal portion of the cuttings be treated with a growth regulator to stimulate development of adventitious roots (*Hartmann and Kester 1968*).

In our research into developing methods for vegetatively propagating superior sugar maple trees, we were interested in determining the type and concentration of stimulant that would bring about the best rooting. Several commercially prepared rooting compounds are available, so we designed an experiment to determine the relative effectiveness of various types and concentrations of these growth regulators.

However, results of the study did not completely achieve this objective. Rather, the results suggest that there is an important relationship between the use of growth substances and individual tree responses to the chemical used.

Materials and Methods

One hundred eighty softwood cuttings—the current year's shoots—were collected from each of three mature sugar maple trees in late June 1967. The cuttings were wounded by making slits approximately ½-inch long on two sides of the basal end. Before being placed in the rooting medium, the lower wounded ends of 20 cuttings from each tree were dipped into one of the following auxin treatments:

- Hormodin No. 3—a commercially prepared powder containing 0.8 percent indolebutyric acid (IBA).[1]
- Jiffy Grow—a commercially prepared liquid containing 0.5 percent IBA and 0.5 percent naphthalene acetic acid (NAA). Cuttings were dipped into the liquid for approximately 5 seconds.
- Jiffy Grow diluted 1:1 with distilled water. Cuttings were dipped into the liquid for approximately 5 seconds.
- Diluted Jiffy Grow plus Hormodin No. 3. Cuttings were dipped into the liquid for about 5 seconds, followed by the powder dip.
- 0.5 percent IBA powder. IBA concentrations were prepared by mixing IBA crystals with the required amounts of talc powder (percents calculated on a weight basis).
- 1.0 percent IBA powder.
- 2.0 percent IBA powder.
- 4.0 percent IBA powder.
- Control (distilled water).

The cuttings were rooted in a 20- x 60-foot plastic-covered greenhouse. Maximum daytime air temperature was approximately 80 to 90°F.; minimum night air temperature was approximately 60°F. The rooting medium was 50 percent by volume of coarse perlite and 50 percent of shredded sphagnum moss. Heating cables maintained the rooting medium temperature at approximately 80°F. The cuttings were watered with intermittent mist and were fertilized with a complete nutrient solution (Rapid Grow) incorporated into an electronically controlled mist system. Supplemental lighting (150-watt incandescent lamps) provided a 20-hour daylength.

[1]Mention of commercial products is for purposes of information only, and should not be taken as an endorsement by the Forest Service or the U.S. Department of Agriculture.

The cuttings were checked for the presence of roots on 26 October 1967, 4 months after they had been collected. The data were analyzed as a randomized block design by the analysis of variance. The trees were considered as blocks with nine treatments (auxins) per block.

Results and Discussion

In general, when the rooting responses of the three trees to auxin treatment were averaged and compared with the untreated controls (table 1), it was found that:

- Undiluted Jiffy Grow and 0.5 percent IBA appeared to stimulate rooting.
- 1.0 percent IBA, 2.0 percent IBA, diluted Jiffy Grow, and Hormodin No. 3 had no effect.
- 4.0 percent IBA and the combination of diluted Jiffy Grow plus Hormodin No. 3 inhibited rooting.

Average effects of a specific concentration of auxin tended to be similar whether the auxin was applied as a powder or as a liquid: 42 percent of the cuttings rooted when treated with Hormodin No. 3 (0.8 percent auxin), and 50 percent rooted when treated with Jiffy

Table 1.—*Response of sugar maple softwood cuttings to applied auxins*

Treatment	Auxin concentration	Rooting Response[1]			
		Tree 1	Tree 2	Tree 3	Average
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Hormodin No. 3	0.8	20	60	45	42
Jiffy Grow	1.0	25	75	50	50
Diluted Jiffy Grow	.5	40	50	35	42
Diluted Jiffy Grow plus Hormodin No. 3	1.3	0	50	30	27
0.5 percent IBA	.5	30	75	40	48
1.0 percent IBA	1.0	10	75	45	43
2.0 percent IBA	2.0	15	75	40	43
4.0 percent IBA	4.0	0	55	35	30
Control	.0	60	60	5	42

[1]Each value represents the rooting percent of 20 cuttings.

Grow (1.0 percent auxin). However, results of the combination Hormodin No. 3 plus diluted Jiffy Grow (1.3 percent total auxin content) were much lower than would be expected: only 27 percent of them rooted when treated with this combination, whereas 43 percent of them rooted when treated with either 1.0 or 2.0 percent IBA powder (table 1). The reason for this apparent anomaly is unknown.

Although, on the average, low concentrations of auxin tended to stimulate rooting, overall treatment effects were not statistically significant. Lack of statistically significant treatment differences was undoubtedly due to the fact that each study tree tested exhibited its own individual response to changes in hormone concentration. Three more or less distinct patterns of response were evident (fig. 1):

- Cuttings from tree No. 1 rooted well without auxins. Auxins, at any concentration, retarded rooting.
- Cuttings from tree No. 2 rooted well without auxin treatment; auxins at low levels caused a moderate increase in rooting; auxins at high levels tended to inhibit rooting.
- Without auxins, tree No. 3 rooted poorly; low levels of auxin caused a substantial increase in rooting, but rooting was reduced at high auxin levels.

The reason for differential tree responses to applied growth hormones is unknown, but these differences may reflect corresponding

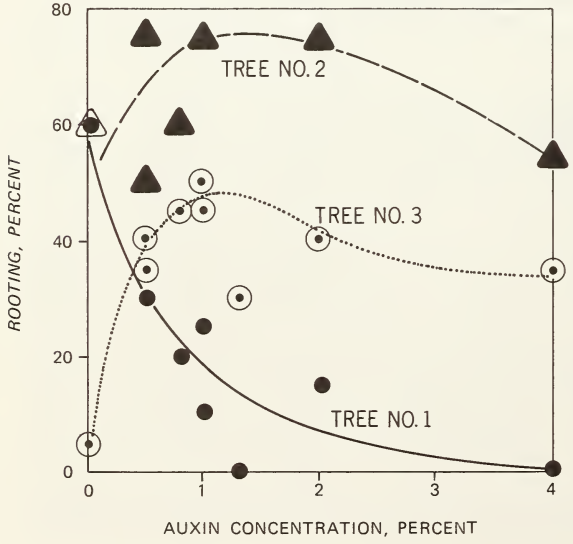

Figure 1.—Rooting response of sugar maple softwood cuttings to applied auxins.

variations in endogenous auxin concentrations within the individual trees. Endogenous auxin concentrations were not measured in the study, but indirect evidence suggests significant tree differences.

Excessive auxin concentrations tended to burn the cutting: the lower stem turned black and rotted. Snow (*1941*) reported similar toxic effects of concentrated solutions.

For tree No. 1, 95 percent of the cuttings treated with 4.0 percent IBA and 90 percent of those treated with diluted Jiffy Grow plus Hormodin No. 3 were burned. In contrast, for study tree No. 2 comparable values for 4.0 percent IBA and diluted Jiffy Grow plus Hormodin No. 3, respectively, were only 40 and 50 percent. And for study tree No. 3, respective values were only 30 and 35 percent. Therefore, the percentage of cuttings burned by concentrated solutions was greater for tree No. 1 than for tree No. 2, and greater for tree No. 2 than for tree No. 3. This suggests that endogenous auxin concentrations may have been higher in study tree No. 1 than in study tree No. 2, and higher in study tree No. 2 than in study tree No. 3.

Each tree's response to applied auxins was in direct opposition to its apparent endogenous auxin content: tree No. 1 had the highest apparent auxin content, and applied auxins inhibited rooting; tree No. 3 had the lowest apparent auxin content, and applied auxins caused significant increases in rooting response.

This inverse relationship between apparent endogenous auxin concentration and the tree's response indicates that effects of endogenous auxins and applied growth regulators may be additive. This relationship also indicates that there may exist an optimum level of total auxins for maximum rooting response. If the auxin concentration within cuttings is low, applied auxins stimulate rooting; but if cuttings possess high concentrations of endogenous auxins, additional amounts may be toxic and may inhibit rooting.

If significant tree differences do exist in the response of sugar maple softwood cuttings to growth regulators, this should be considered when attempting to vegetatively reproduce selected individuals of this species. Although the effects of growth regulators have been tested in numerous studies, differential tree responses to treatment have seldom been reported. However, Doran (*1946*) detected clonal differences in the response of *Tsuga canadensis* cuttings to auxin treatments, and Achterberg (*1959*) reported that effects of growth substances were often obscured by individual tree differences.

The possibility of tree differences in the response of cuttings to applied auxins has important implications in the development of a program for vegetatively propagating selected sugar maple trees. Significant tree differences in rooting response, observed here in the past and by other workers with other species, could well be due to differential response to applied auxins. This concept deserves a closer look.

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